

Preliminary Investigation Report

Puget Sound Refinery East Flare Decontamination Odor Event

Incident Began: February 20, 2015 14:30

Initial Fact Finding: February 20, 2015 17:00

Preliminary Investigation Began: February 21, 2015 8:00

Report Date: February 21, 2015 16:00

Team: Scott Mayhew, Operations Lead

Michael Moore, Process Engineering Lead

Lisa Augustine, Process Engineering

Mike Estrada, Process Engineering

Steve Bertels, Operations

Pat Mullen, Operations and TOP Representative

Preliminary Investigation Structure

On February 21st, the morning following the subject flare odor incident, the team above was formed to investigate the physical cause (s) that led to the odor event. The deliverables of this team were an Event Summary, Sequence of Events and Timeline, and a description of the most probable root causes. The team reported out at 16:00 on February 21st to a cross-section of Refinery LT, ELT, Technical, and Engineering personnel. The purpose of this initial investigation was to give the Refinery LT and ELT enough data regarding the incident such that a decision could be made on how to progress with this work.

Event Summary

On the morning of February 20th, the East Flare, one of three flare systems at the Puget Sound Refinery, was taken out of service for planned maintenance and safety and environmental improvements¹. At this time, a number of other refinery process units were already shut down for maintenance, thus allowing this flare to be safely taken out of service.

¹ Flare Mole Seal Repair, Pilot Repairs, Pilot Thermocouple Repairs, Purge Natural Gas Flowmeter Addition, Flare Analyzer Addition, and KO Drum Strainer Valve Replacements.



The process of decontaminating the vessels² and lines associated with this flare system requires the system to be heated with steam, flushed with hot condensate (KO Drum), and chemically treated. Heating of the process started in the afternoon of February 20th. Shortly after main steam supply was introduced to heat the two vessels and flare lines at 12:30, Shell personnel started proactively monitoring the surrounding offsite areas for odors.

No odors were detected through the process until an offsite odor complaint was received starting around 14:30, when the Northside Site Team Lead (STL) received a call of an odor complaint from a business just south of the refinery. Additional STL's were sent off-site and confirmed the complaint. Shell Operations immediately reduced and then isolated all heat sources being utilized to decontaminate the flare and reestablished a purge of natural gas in response to the odor complaints.

At approximately 15:35, Skagit County Department of Emergency Management Director, Mark Watkinson, contacted the refinery asking about operations at PSR since 9-1-1 had been receiving numerous odor complaint calls for the last hour. At 15:50, PSR called 9-1-1 to initiate a CAER Level 0 notification regarding the odors for the area south of the refinery.

Between 16:00 and 17:00, Shell Safety personnel monitored the surrounding area and did not detect any harmful compounds in the form of CO, SO₂, H₂S, or hydrocarbons. Data indicates the release of material that would have potentially created the odor was eliminated at approximately 16:30 once the natural gas purge to the flare was reestablished. The complaints to the site ceased at approximately 20:00.

All decontamination of the east flare system was halted until further investigation could be completed to fully understand the root cause of the odors.

Sequence of Events

Some timestamps below are approximate³; however, the sequence in which they are presented is correct.

February 20, 2015	
08:45	East Flare Blocked and Isolated ^{4 5} .
10:27	250# Steam introduced to the bottom Flare KO Drum (3/4" hose).
12:30	250# Steam introduced to the KO Drum via 2" connection.
13:25	Flare Seal Pot empty.
13:47	Steam temperature indicated at Flare Temperature Analyzer.
14:09	Operations blocked in steam to bottom of Flare KO Drum (3/4" hose).

² 19NC3 (Flare KO Drum) and 19NC6 (Flare Seal Pot)

³ The data sources are Raddical Connect, Operating Procedures (Outside Operator and Console), Radio Transmissions, reports from the previous evening, and interviews with those involved.

⁴ See Appended A for the East Flare Isolation Schematic.

⁵ Note: The pilots remained in service during this time.

14:18	Operations blocked in natural gas purge to the Flare.
<i>The investigation team deduces that when the natural gas purge was blocked in; this was the time when light sour product being vaped off in the KO Drum was released from the flare, creating the odor.</i>	
14:30	Initial reports of odor complaints off-site South of the refinery.
15:36	Trimmed back 250# Steam to the KO Drum in response to the odor complaint .
16:15	Flare temperature analyzer indicates a drop in temperature.
16:16	Operations reestablished natural gas purge to the Flare .
16:17	250# Steam completely blocked in at the Flare KO Drum .
<i>The investigation team deduces that shortly after the steam was blocked in at the Flare KO Drum and natural gas purge was lined up the flare, there was no longer any odors emanating from the flare. The motive steam moving the sour light ends from the KO drum was blocked in and any residual sour light ends in the line were being destroyed at the flare tip with the combustion of the natural gas purge.</i>	
17:38	Flare Seal Pot level reestablished .
18:00	Flare temperature returns to normal (pre decontamination temperature) .
20:00	Odor complaints to the refinery cease.
February 21, 2015	
8:00	Applicable Refinery Leadership, Operations, Technical, and Engineering personnel meet to discuss the event and kick off preliminary investigations.
9:00	Decision made to activate EOC.
16:00	Preliminary Investigation team reports out on findings.

Physical Root Cause Analysis

Through the review of the sequence of events and available data, the team determined there were five mechanisms that could have potentially caused the odor during the flare decontamination work. Efforts were made to either prove or disprove these theories:

Most Probable	<ul style="list-style-type: none"> Light sour product in the Flare KO Drum was vaped -off and carried through the flare out the tip once the natural gas purge was closed. The closure of the purge gas eliminated the majority of the combustion at the tip, thus allowing the light sour ends to escape into the environment.
Probable Contributor	<ul style="list-style-type: none"> Light sour product residual in the flare line vapor ed-off and carried through the flare out the tip once the natural gas purge was closed.
Not Possible	<ul style="list-style-type: none"> 30" Flare Valve (Isolation upstream of KO Drum) was leaking, allowing products from the sour flare system into the KO Drum. Sweet Flare Isolation valve leak-by, allowing products from the sweet flare system into the flare line downstream of the Flare Seal Pot.
Very Low Potential	<ul style="list-style-type: none"> Fuel Gas Isolation valve leak-by, allowing products from the fuel gas system into the seal pot.

The information below will detail these mechanisms and describe why the data indicates the 1st and 2nd bullets are the most probable contributors to this event.

Physical Root Cause Analysis

Potential Failure Mechanism Detail

	Most Probable	Probable Contributor	Very Low Probability	Not Possible
Mechanism Description	Light sour product in the Flare KO Drum was vaporized-off and carried through the flare out the tip once the natural gas purge was closed. The closure of the purge gas eliminated the majority of the combustion of the tip, thus allowing the light sour ends to escape into the environment.	Light sour product residual in the flare line vaporized-off and carried through the flare out the tip once the natural gas purge was closed.	Fuel Gas Isolation valve leak - by, allowing products from the fuel gas system into the seal pot.	Sweet Flare Isolation valve leak - by, allowing products from the sweet flare system into the flare line downstream of the Flare Seal Pot 30" Flare Valve (Isolation upstream of KO Drum) was leaking, allowing products from the sour flare system into the KO Drum.
Data to Validate or Disprove the Mechanism	<p>Data that Validates this Mechanism :</p> <p><i>Contributed to Sour Light Ends Vaporizing Off:</i></p> <ul style="list-style-type: none"> Hot condensate in KO Drum 250# Steam introduced to KO Drum (bottom 3/4" and main 2") KO Drum Validated Hot by Ops Residual 6" sludge layer in KO Drum after flush (likely sour product) validated by IR imaging. <p><i>Contributed to Sour Light Ends Moving to Flare Tip:</i></p> <ul style="list-style-type: none"> TI at flare stack indicated steam as flowing through drums to the flare Visual indication of steam at flare tip 	<p>Data that Validates this Mechanism:</p> <ul style="list-style-type: none"> 250# Steam introduced to flare system. Flare line validated Hot by Ops Residual sour product in flare lines <p>Data that indicates this was only a partial contributor:</p> <ul style="list-style-type: none"> Flare system is sloped back to KO drum, thus there would not have been any bulk sour material in the lines, only residual. 	<p>Data that Disproves this Mechanism:</p> <ul style="list-style-type: none"> Ops verified the FG valve closed. While there is the potential for sour product in the FG system, there were no indications of this occurring at the time. FG leakage alone would not have yielded the odor reported and would have likely been burnt at the tip given the FG BTU value at the time of the event. 	<p>Data that Disproves this Mechanism:</p> <p>The pressure in the east flare system at the time of the event was higher than the pressure in the flare systems (upstream of the 30" valve and sweet flare). This indicates if there had been a leak at either of these isolation points, there would have been steam flowing back into those systems.</p>
Conclusion	The sour light ends being vaporized off in the KO drum and partially in the flare line were being carried to the flare tip and being destructured with the combustion of the natural gas purge. At the time the purge gas was shut off to continue the steam out and introduce the chemical treatment, there was still a high volume of sour light ends being carried to the tip through the motive steam. Without the combustion at the tip with the purge gas, the sour light ends escaped the flare tip into the environment, creating the odors.			

Appendix A: East Flare System Isolation

This drawing also identifies the work to be completed on the flare during this outage.

